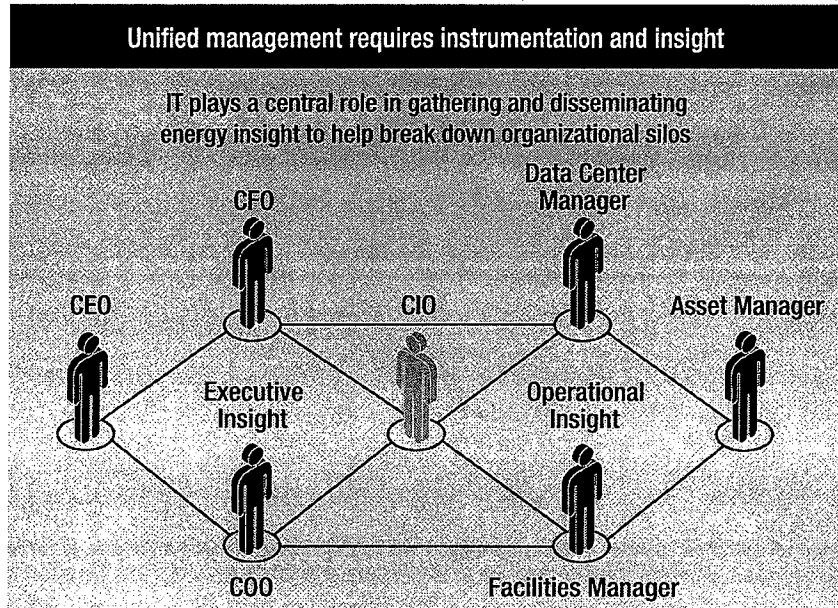## IT is at the center of energy management and optimization

It is clear that managing energy consumption across your infrastructure leads to greater efficiencies and cost savings. IT is uniquely positioned to support the instrumentation of the infrastructure and deliver visibility into the ongoing energy and environmental impact. IT can leverage a common set of tools and views to break down organizational silos and communicate performance gains and potential opportunities. Armed with the proper tools and information, IT can demonstrate leadership and accountability to help you achieve company-wide sustainability goals and objectives.

To more quickly realize the benefits of monitoring and managing your energy consumption, IBM Global Services offers technology services to assist you in implementing your energy dashboard, or in launching a broad-range energy management plan.

For more information

To learn more about how IBM Service Management Solutions can help your organization better manage energy consumption by implementing an

Unified management requires instrumentation and insight

IT plays a central role in gathering and disseminating energy insight to help break down organizational silos

CEO · CFO · CIO · Data Center Manager · Asset Manager · Executive Insight · Operational Insight · COO · Facilities Manager

IT plays a central role in disseminating valuable energy information to stakeholders.

energy dashboard, contact your IBM representative or IBM Business Partner, or visit **ibm.com**

About IBM Service Management

IBM Service Management Solutions help organizations manage their business infrastructure and deliver quality service that is effectively managed, continuous and secure for users, customers and partners. Organizations of every size can leverage IBM services, software and hardware to plan, execute and manage initiatives for service and asset management, security and business resilience. Flexible, modular offerings span business management, IT development, operations management and system administration, and draw on extensive customer experience, best practices and open standards—based technology. IBM acts as a strategic partner to help customers implement the right solutions to achieve rapid business results and accelerate business growth.
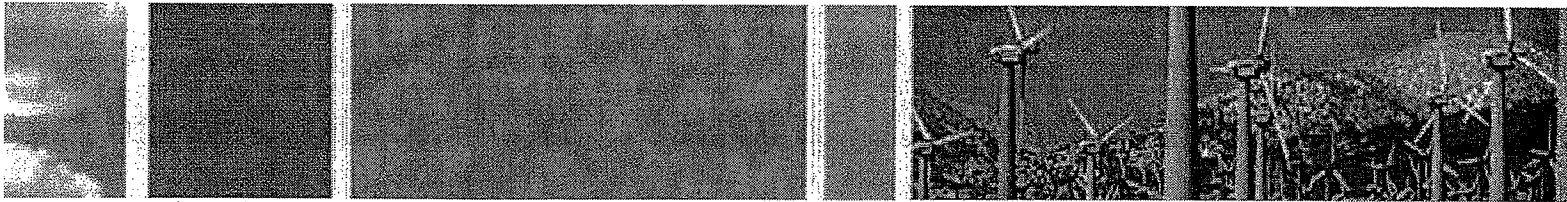
The green data center

More than social responsibility: A foundation for growth, economic gain and operating stability
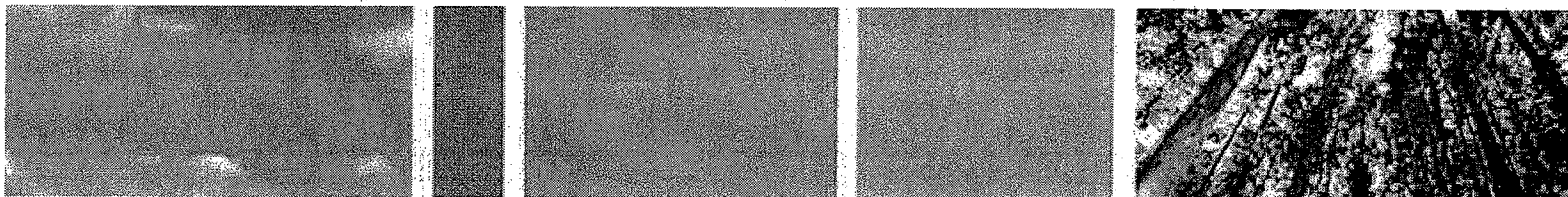
Challenges facing CIOs transitioning to a green data center

- Whose job is it?
- Reducing cooling requirements
- Increasing facilities system efficiency
- Reducing power consumption with innovative technologies
- Do you have a game plan?

Introduction

Industry analysts have verified our findings that the data center is in crisis, noting that data center energy costs are 10 to 30 times more than a typical office building. It has also been reported that data centers have doubled their energy use in the past five years.[1] That is a significant increase in a very short period of time—an increase that is getting the attention of CIOs.

After years of being viewed by many as a concern for a relative few, environmental issues are now front-page news around the world. Faced with increasingly urgent warnings about the consequences of the projected rise in both energy demands and greenhouse gas emissions, governments and businesses alike are now focusing more attention than ever on the need to improve energy efficiency. For most CEOs, whose sights are firmly fixed on business growth and expansion, energy consumption and environmental concerns can take on a whole new meaning when they begin to impede the company's ability to grow. Corporate data centers are well known as significant power users. If the company's data center cannot accommodate new servers or storage because of power availability or infrastructure constraints, bringing new capabilities online can become a major challenge in terms of both time and money. For CIOs, that translates into finding ways to expand the capacity of data operations to meet the growth requirements of the business. A growing number of CIOs are realizing that environmental concern and business success can go hand in hand—and that a green, or environmentally friendly, data center may actually be one of the best ways to both accommodate growth and make a positive impact on their business's bottom line.

While creating an energy efficient data center can be a complex undertaking, there are many solutions and techniques available to support the transition.

With energy costs rising and information technology (IT) equipment stressing the power and cooling infrastructure—which, in turn, threatens operating resiliency—many see an economic and operational crisis looming. CIOs today are being challenged to rethink their data center strategies, adding energy efficiency to a list of critical operating parameters that already includes serviceability, reliability and performance. A data center efficiency initiative can help a company regain power and cooling capacity, recapture resiliency and help meet business needs—while, at the same time, dramatically reducing energy costs and the total cost of ownership. To further reward companies for energy-conscious behavior, many local utility and state energy funds are offering economic incentives or rebates for measures that reduce energy consumption.

Transitioning to an energy efficient data center and optimizing operating efficiency can be a complex undertaking. There are multiple components to factor into the equation—and best results are often achieved by integrating improvements from multiple fronts. The good news is that there are many solutions and techniques available to support such a transition. Furthermore, the process can occur in a step-wise manner, reducing risks and helping to realize benefits along the way. Going green is becoming more than an altruistic aspiration to save the planet. It's now clear that acting in an environmentally responsible manner is a necessity that companies will need to embrace—sooner rather than later—to survive economically.

High-density rack-mounted servers can increase hot spots and tax cooling systems, making it difficult for aging data centers to keep up with today's demands.

Challenges facing CIOs

Responding to customer demand for better performance at lower prices, the information technology industry has delivered faster servers, lower-cost storage and more flexible networking equipment. While these new components can often deliver ever-greater performance per unit of power, they can also be increasingly power hungry. In addition, the evolution of high-density, rack-mounted servers has typically increased heat density, creating hot spots and taxing cooling systems. The excessive heat can also threaten operating stability, resiliency and staff productivity.

Many of the data centers housing this "hot" new technology are now 10 to 15 years old. As a result, their critical infrastructure equipment is likely to be growing inefficient and reaching the end of its useful life. These aging data centers are having a hard time keeping up with today's demands. Typical data centers draw approximately one half to three times the amount of power required for the IT equipment because conventional data center designs are oversized for maximum capacity and older infrastructure components can be very inefficient.[2] The cost associated with this level of power consumption can significantly impact the total cost of ownership for data center facilities and IT systems.

The rising cost of a kilowatt of electricity has further compounded the problem. Cooling and electrical costs currently represent up to 44 percent of a data center's total cost of ownership.[3] According to The Uptime Institute, the three-year cost of powering and cooling servers is currently one-and-a-half times the cost of purchasing server hardware.[4] As a high-level university administrator recently discovered,

Cooling and electrical costs represent up to 44 percent of a data center's total cost of ownership[3] although some companies are finding that they can't buy extra electricity at any price.

"With the growing demand for cheaper and ever-more-powerful high-performance computer clusters, the problem is not just paying for the computers, but determining whether we have the budget to pay for power and cooling."

Meanwhile, some companies can't even deploy more servers because extra electricity isn't available at any price. Many utilities, especially those in crowded urban areas, are telling customers that power feeds are at capacity and they simply have no more power to sell.

A study by Jonathan Koomey, Lawrence Berkeley National Laboratory and Stanford University, has indicated that server energy demand has doubled from 2000 to 2005. The study estimates that power used by servers, cooling and ancillary infrastructure in 2005 accounted for about 1.2 percent of the United States' electrical usage—the equivalent in capacity terms of about five 1,000 MW power plants.[5]

This issue hasn't escaped the attention of power companies or government organizations. In the U.S., over 80 local utility and state energy efficiency programs are offering rebates for increasing energy efficiency.[6] One of the first utilities to offer such a program is Pacific Gas and Electric (PG&E) of California. The company has approved a plan to reimburse part of the costs of server and storage consolidation projects, including software, hardware and consulting, up to a maximum of US$4 million per customer. Marc Bramfitt of PG&E said, "We don't want to build any more power plants. We want our customers to save energy and we'll pay them to do so."[7]

With energy costs rising and in limited supply, the data center infrastructure is being taxed and its ability to meet business demands is at stake.

In addition, governments at both the country and regional levels are initiating energy efficiency programs. In the United States, the U.S. Department of Energy and the U.S. Environmental Protection Agency are developing assessments and rating systems for data centers and IT equipment.[8] The European Union has established a directive to drive a 20 percent reduction in energy usage by 2020.[9] And Australia requires all companies using more than 150,000 MWH of electricity per year to prepare an energy efficient assessment and action plan.[10]

The message is clear: Energy costs are rising, supply is limited, the data center infrastructure is being taxed, and its ability to meet business demands is at stake. CIOs who want to solve these problems will need to focus on data center innovation. Fortunately, green strategies and technologies exist today to help optimize space, power, cooling and resiliency while improving operational management and reducing costs—at the same time, helping to position companies for growth and enabling CIOs to meet expanding business needs.

Transitioning to a green data center

How do you go about creating an energy-efficient green data center? IBM's 30-plus years of extensive, hands-on experience in designing, supporting and operating data centers has allowed it countless opportunities to learn what works and what doesn't. It's also provided us with a unique perspective on how to apply that learning to help create workable strategies for improving energy efficiency.

The technologies and strategies for improving data center energy efficiency span the data center ecosystem.

As the following graphic shows, the technologies and strategies for improving data center energy efficiency span the data center ecosystem. Companies typically achieve the best results by addressing both the physical infrastructure and the Information Technology equipment. Advanced technologies such as virtualization, energy efficient hardware, and advanced datacenter management software can increase equipment utilization and match power use to workload demand. Further gains can be realized by using more efficient infrastructure equipment and matching cooling delivery to power demand.
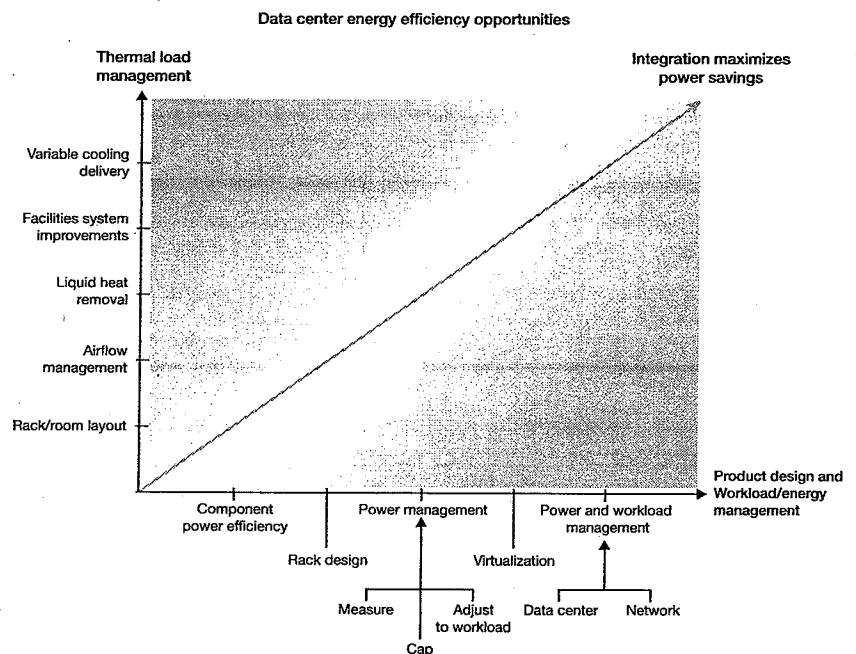
Data center energy efficiency opportunities

A best practices assessment and energy audit make it possible to pinpoint areas of high energy use, while establishing a baseline for further planning.

Although there is clearly no single "right way" to create a green—and energy efficient—data center, experts believe that the most productive first step for CIOs is to conduct a data center energy audit to "get the facts" on their energy usage. This systematic approach offers a real-time profile of the data center's energy use and evaluates it against an industry metric for the data center energy efficiency—called either the Power Usage Effectiveness (PUE) or the Data Center Infrastructure Effectiveness (DCiE). These metrics and the detailed measurements of power usage make it possible to establish a baseline for future planning and to pinpoint areas of inefficient energy use.[11]

At the same time, CIOs should develop a holistic view of the environment, taking the following factors into account:

- An inventory of your current systems, their power usage and locations
- Your company's business and growth plans—to help forecast future needs
- Current or planned governmental energy efficiency regulations in your area
- Available energy efficiency rebates or economic incentives from government programs or your energy provider
- Any already established goals for reducing your company's carbon or greenhouse gas emissions inventory—and the timeframe set for achieving those goals.

Opportunities to improve energy efficiency can range from major infrastructure upgrade projects to a number of simple and inexpensive measures.

A careful review of the assessment and profile will allow a CIO to build a list of opportunities to drive maximum energy efficiency in the data center. If the team hasn't yet looked closely at the thermal characteristics of the company's data center, it's likely that they'll find many opportunities to improve energy efficiency. They can range from major infrastructure upgrade projects such as upgrading chillers or uninterruptible power supplies (UPS) to simple and inexpensive measures, including:

- Blocking cable openings to prevent cold air waste in the hot aisle
- Removing under-floor cable blockages that impede airflow
- Turning off servers that are not doing any work
- Turning off computer room air conditioning (CRAC) units in areas that are over provisioned for cooling
- Optimizing perforated tile locations
- Blanking panels internal to server racks to fill empty positions

Of course, any analysis of your current situation needs to recognize the likelihood that business needs will change. For example, it would be wise to employ a modular approach to the design of future power and cooling capacity, allowing for easy expansion or modification. Factoring in local conditions and time periods can also be important. While IT equipment and UPS usage probably will be fairly constant, chiller or heating, ventilation and air conditioning (HVAC) energy usage will vary with outdoor temperature and humidity conditions. In addition, it's important to ensure that power and cooling scenarios are designed for recovery, and not just for steady-state operation.

Facilities and IT departments need to collaborate—sometimes with the addition of outside help—in finding ways to meet environmental and energy challenges.

Whose job is it?

Until recently, environmental management and energy expenditures were typically the responsibility of facilities departments. But rising energy costs and evolving IT demands are changing all that. It's becoming critical that the facilities and IT departments form a partnership and collaborate in this area. Even then, many companies will not have the skills or the tools to profile and model thermal conditions and appropriately apply the information to data center planning or upgrades. Because these are highly specialized skills, obtaining outside help during this part of the process may be well worth the investment.

Reducing cooling requirements—the major physical infrastructure user of energy

According to Gartner, "Traditionally, the power required for non-IT equipment in the data center (such as that for cooling, fans, pumps, and UPS systems) represented, on average, about 60% of total energy consumption."[12] Based on the best practices in IBM data centers and the results of doing dozens on data center energy audits in the past year, there are a number of factors that should be considered in developing a plan for improving power and cooling efficiency by reducing the heat generated in the data center.

All of these will help you effectively manage the air flow to the IT equipment and can increase energy efficiency with relatively low upfront investment. The opportunities include:

- Implementing strict hot and cold aisle installation practices, including blanking plates, proper placement of perforated tiles and reducing under-floor air dams
- Positioning the equipment so you can control the airflow between the hot and cold aisles and prevent hot air from recirculating back to the IT equipment cooling intakes
- Leveraging low-cost supplemental cooling options—such as water or refrigerant heat exchangers

- Improving rack cooling efficiency by employing a rear-door heat exchanger or an enclosed racking system to dissipate heat from high-density computer systems before it enters the room. The rear door heat exchanger is like putting a car radiator on the back of the server as it uses coolant that is being pumped into the data center to run the air-conditioning systems already—it circulates that coolant to kind of a car radiator at the back of the server. In many cases this takes up to 55% of the heat generated from a rack before it exhausts into the room, significantly reducing the energy consumption by the air conditioning system. For lower powered racks (less than 10 kw), it may be possible to remove 100% of the rack heat load from the rear-door heat exchanger.[13]

Similarly, relatively simple airflow management improvements can boost energy efficiency. For example, you can:

- Take advantage of the current capacity by clearing under-floor blockages and implementing effective cable management
- Ensure that floor openings match the equipment thermal load by adding or removing perforated tiles at the equipment air intakes
- Consider adding ducted returns

Organizing data centers into thermal zones can eliminate hot spots that challenge cooling systems and enhance system reliability by helping to avoid heat-related hardware failures.

Ultimately, companies should consider organizing their data centers into thermal zones—assigning a defined set of IT equipment and floor space to specific HVAC or CRAC units. This type of space and thermal planning will eliminate hot spots that challenge cooling systems and will enhance system reliability by helping to avoid heat-related hardware failures.

Improving physical infrastructure systems—don't hog the power

A recent survey indicated over 50% of customers are looking to make incremental improvements to their data centers to increase energy efficiency.[14] This is especially true with the UPS and chiller systems that have useful lives of 15 or more years.

One of the biggest improvements we have found from our data center energy efficiency assessments is the need to improve the efficiency of the UPS systems. Many clients are not matching the IT load to the size of the UPS systems, which results in over-provisioned and inefficient power systems.

In addition, companies can save energy and gain cooling capacity by relaxing stringent relative humidity and temperature requirements for their data centers. Effective air management can lead to the ability to increase the CRAC unit utilization by increasing the air discharge temperatures (and chilled water temperatures if applicable) while still adequately cooling IT loads. Proper control settings can significantly reduce energy usage. Since these specifications are usually driven by the presence of hot spots, removing those hot spots will relax temperature and relative humidity requirements, helping reduce the energy required to operate the data center. Current ASHRAE Class 1 and 2 environmental guidelines recommend 20 to 25 C and 40 to 55% inlet air conditions. The ASHRAE TC9.9 committee has increased these recommended environmental conditions in July of 2008 to 18 to 27 C, a recommended lower limit of relative humidity between 25% and 45% depending on dry bulb and dew point temperature and an upper limit of 60% to allow customers to utilize more energy efficient solutions for their data centers.[15]

When looking to build a new data center or retrofit an existing data center it makes sense to look to new infrastructure equipment, since energy efficiency has significantly improved in recent years. Replacing chiller or UPS systems that have been in service for 15 years or more can result in substantial savings. For example, a 5% increase in the efficiency of a UPS unit can save over 422 MWH/yr ($38,000/yr) in a 15,000 square foot data center with no discernable impact on the data center's operation.[16] New chiller plants also can be installed with variable-speed drives, reducing pumping system energy usage and allowing better integration of the liquid cooling system into the chilled water infrastructure. Water-side economizers, which utilize outside air to directly cool the chilled water, can further reduce the energy required to run the chillers.

New chiller systems, thermal storage systems and air delivery systems can help reduce both energy requirements and costs.

The capacity and efficiency of chilled water systems can be augmented with thermal storage systems that store energy generated at night, when chillers typically operate more efficiently, and then release this energy during the day, when energy costs are higher.

Air delivery to the data center also can be made more efficient, either through central HVAC systems or through CRAC units with variable speed drives. Central HVAC tends to be more efficient, as the systems are larger and more amenable to taking advantage of no-cost cooling when outside air temperatures are sufficiently low to provide some or all of the cooling requirements. CRAC units, on the other hand, provide greater flexibility in managing the data center.

In addition to cutting back on power usage inside its data center, a company can also reduce carbon emissions associated with energy use by taking advantage of options for more eco-friendly sources of power. Integrating renewable energy into the power distribution network—including solar, wind, hydro and bio-mass generated energy—is a good way to reduce dependency on fossil fuels. Companies with the flexibility to relocate or open new data centers are even choosing locations that are rich in renewable energy sources as part of their corporate environmental strategy.

Don't forget your building systems

While lighting in the data center may only account for 2 percent of the total energy used, it can often be a "low hanging fruit" type of line item. Implementing occupancy sensor lighting controls in the raised floor area, to turn off lights when not needed, is one item to consider.

Reducing power consumption with innovative technologies

With IT equipment becoming more energy efficient and greener all the time, replacing older IT equipment with newer models can reduce overall power and cooling requirements.

Applying innovative technologies within the data center can yield more computing power per kilowatt. IT equipment is becoming more energy efficient all the time. With technology evolution and innovation outpacing the life expectancy of data center equipment, many companies are finding that replacing older IT equipment with newer models can significantly reduce overall power and cooling requirements and free up valuable floor space. For example, IBM studies have demonstrated that blade servers save 35% on power, reducing power and cooling requirements over 1U technologies.[17] While it may seem financially unwise to replace equipment before it is fully depreciated, the advantages that new models can offer—lower energy consumption, plus two to three times more computing power than older models—combined with potential space, power and cooling recoveries are enough to offset any lost asset value.

Conventional servers use at least 60% of their peak power when idle.[18]

Virtualization

Virtualization can be a tremendous ally in reducing heat and expense—simply because it means that you'll need fewer servers. Servers use energy and give off heat whether they're in use 100 percent of the time or 15 percent of the time. Chase et al. found that conventional servers used at least 60% of their peak power when idle. In fact, all but one system used over 74% of their peak power at idle.[18] As cooling load delivery in a data center is fairly constant, there is currently a minimal difference between the energy required to operate and cool a server whether it is at full load or in idle. Thus, driving up server utilization delivers a significant increase in workload delivered with a minimal increase in energy consumed.

Virtualization is a technology designed to enable multiple application workloads— each having an independent computing environment and service level objectives— to run on a single machine. This eliminates the approach of dedicating a single workload to a single server—a practice that yields low utilization rates—and allows virtualized servers to function near maximum capacity. A virtualized environment also is typically more resilient than a dedicated server environment. Component failures can be automatically managed, and the workload restarted. What's more, resources in a virtualized environment can be managed from a single point of control, improving operations.

Just as server virtualization reduces the number of servers needed, storage virtualization reduces the number of spindles required.

The advantages of virtualization are not limited to servers. Storage virtualization can be used to combine storage capacity from multiple vendors into a single reservoir of capacity that can be managed from a central point. Just as server virtualization reduces the number of servers needed, storage virtualization reduces the number of spindles required, increasing the total amount of available disk space and optimizing utilization rates. Storage virtualization can also improve application availability by insulating host applications from changes to the physical storage infrastructure.

Application Infrastructure Virtualization (AIV) provides the ability to separate the underlying infrastructure from the applications that run on it. Workloads can then be dynamically placed and migrated across a pool of application server resources, allowing the infrastructure to dynamically adapt and respond to business needs and requests to be prioritized and intelligently routed to respond to the most critical applications and users.

AIV frees the enterprise from a tight coupling between an application and associated application servers. This loose coupling enables open standards-based software to intelligently manage and shift workloads according to agreed-upon business policy. For instance, high-priority applications can be allocated the majority of resources; lower priority applications are either designed to run later or moved to less capable resources. These operations are all seamless to the user.

Virtualization, especially when coupled with the green design of new server and storage hardware, offers an effective solution for keeping power and cooling costs in check. The most energy efficient equipment is equipment that's no longer in use—whether it's a server, a router or a storage device.

With virtualization, you can consolidate the workloads currently on a multitude of underutilized devices onto fewer, more efficient pieces of equipment—and begin to realize possible savings and efficiencies beyond what can be achieved through the design of even the greenest systems or buildings alone.

New power management technology makes it possible to meter actual power usage and cap the amount of power used by a single server or group of servers.

Power management in IT systems

Once you have established your baseline with an energy audit and understand how energy efficient your data center is today, you need to have an ongoing way to measure and manage your energy usage between the IT and facility equipment. Ideally, power usage in a data center should be proportional to the workload. One way to achieve this balance is to idle unneeded equipment. It's a technique that's effective but difficult to manage. New power management technology, however, gives data center managers full control over optimizing power consumption—thanks to workload management software and hardware capabilities. This technology makes it possible to meter actual power usage and produce trend data for any

Going green at IBM

Like many companies, IBM has found that supporting environment-friendly initiatives can be a smart business move. A significant area of focus is reducing a company's carbon footprint, or the amount of carbon dioxide (CO2) emissions a company is directly or indirectly responsible for producing. Power consumption is considered an indirect contributor to a company's carbon footprint because power companies produce CO2 emissions in the generation of electricity.

IBM has announced that we will double compute capacity by 2010 without increasing our power consumption or carbon footprint, saving 5 billion kilowatt hours per year—equivalent to energy consumed by Paris, "the City of Lights."[20]

single physical system or group of systems. The amount of power used by a single server or groups of servers can be capped—based on workloads and business trends—to optimize energy use and application performance without sacrificing productivity.

Eco-friendly disposal

IBM surveys find that fewer than 55% of clients have a plan for the responsible disposal of their assets. In fact, environmentally responsible disposal offerings are available to facilitate and accelerate the movement to greener equipment.[19] These services dispose of systems in an eco-friendly manner, redeploying systems with a useful life and typically ensuring compliance with regulations and removing data before disposal. Best of all, some programs will pay market value for the old equipment.

Do you have a game plan?

Most companies expect that their CIOs will supply a reliable, high-performance infrastructure to support the business within their allocated budgets. Are you prepared to continue meeting this expectation in the changing environment?

Do you know for sure that your data center can meet growing power and cooling demands? Yet, less than 80% of CIOs have direct accountability for the energy used in the data centers.[21] Do you have a plan to manage the impact of rising energy costs? Are you taking advantage of financial incentives or rebates? Are you prepared to contribute to corporate initiatives to reduce greenhouse gas emissions? Do you have a strategy for your data center to ensure that you can continue to meet your company's expectations? If your answer is not a resounding "yes" to meet of these questions, perhaps the time has come to evaluate your strategy.

The US Environmental Protection Agency has confirmed IBM estimates that it is possible to save between 25 to 55 percent of your annual data center energy bill by implementing simple to best practices for both your IT and physical infrastructure.[22]

Project Big Green

Project Big Green is a $1 billion investment to dramatically increase the efficiency of IBM products. New IBM products and services, announced as part of Project Big Green, include a five-step approach to energy efficiency in the data center that, if followed, can sharply reduce data center energy consumption and transform clients' technology infrastructure into "green" data centers.

CIOs' ongoing efforts to think green can help keep their companies operating in the black.

Conclusion

As governments and corporations intensify their focus on reducing energy demands and greenhouse gas emissions, pressure to improve data center energy efficiency will continue to grow. We believe that the following "four Rs" must play an essential role in the development of any initiative to create a green data center:

- Regain power and cooling capacity
- Recapture resiliency
- Reduce energy costs
- Recycle end-of-life equipment.

Successful CIOs will make these four Rs their mantra. And in doing so, their ongoing efforts to think green will help keep their companies operating in the black.

Contributors

Jay Dietrich, professional engineer and senior technical staff member, corporate environmental affairs. Jay is responsible for corporate environmental policy for climate stewardship and energy and represents IBM on these issues with clients, U.S. EPA, and other governmental and nongovernmental groups that are active on energy efficiency issues. Jay can be reached at jdietric@us.ibm.com.

Roger Schmidt, distinguished engineer (thermal engineering), IBM Systems and Technology Group. Roger has more than 25 years of experience in the thermal design of IBM's large-scale computers and is named on more than 25 patents for IBM thermal technology. His professional memberships and titles include ASHRAE TC 9.9 Mission Critical Facilities, IBM Chief Thermal Architect, IBM Academy of Technology member, National Academy of Engineering member and ASME Fellow. Roger can be reached at c28rrs@us.ibm.com.

Mike Hogan, professional engineer and IBM Certified I/T Specialist—Infrastructure. Mike is responsible for the global offering development and deployment of IBM's data center energy efficiency assessment.

Gerry Allen, RESO site operations manager, responsible for eight strategic data centers in the US. These locations comprise 1.3M sq ft of raised floor. Gerry's team is responsible for site facility operations, maintenance, energy management, and projects. Gerry is a mechanical engineer with 30 years of experience in facility design, construction and operations.

IBM®
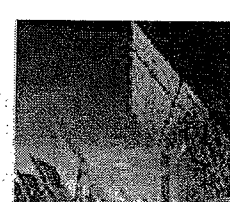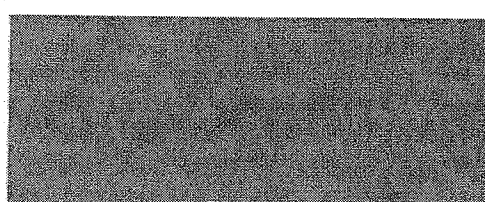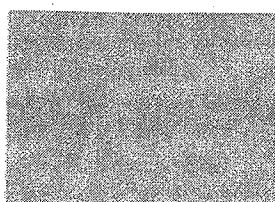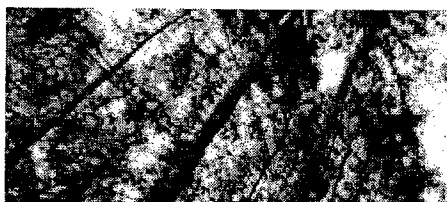
For more information

To learn more about creating a green data center, please contact your IBM marketing representative or IBM Business Partner, or visit the following Web sites:

ibm.com/systems/greendatacenter

redbooks.ibm.com/redpieces/abstracts/redp4413.html

[1] IDC "Worldwide Server Power and Cooling Expense 2006-2010," Document #203598, September 2006.2"

[2] Neil Rasmussen, "Electrical Efficiency Modeling of Data Centers," White Paper 113, American Power Conversion (APC), 2005.

[3] Neil Rasmussen, "Implementing Energy Efficient Data Centers," White Paper #114, American Power Conversion Corporation (APC) 2006.

[4] Kenneth G. Brill, "Data Center Energy Efficiency and Productivity," The Uptime Institute, 2007.

[5] Jonathan G. Koomey Ph.D. Staff Scientist, Lawrence Berkeley National Laboratory and Consulting Professor, Stanford University, "Estimating total power consumption by servers in the U.S. and the world," February 15, 2007.

[6] Database of State Incentives for Renewables and Efficiency: http://www.dsireusa.org/

[7] Alex Barrett, "For PG&E customers, it pays to virtualize," SearchServerVirtualization.com, October 26, 2006.
http://searchservervirtualization.techtarget.com/originalContent/0,289142,sid94_gci1226458,00.html

[8] National Datacenter Energy Efficiency Information Program:
http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency#ndceeip

[9] 20 20 by 2020: Europe's Climate Change Opportunity: http://ec.europa.eu/energy/climate_actions/index_en.htm

[10] Energy Efficiency Opportunities Act and Regulation:
http://www.energyefficiencyopportunities.gov.au/

[11] http://www.ibm.com/itsolutions/energy-efficiency/?S_TACT=6N8AJ21W&&S_CMP=Green2.0_Web_Bathwick_Tool

[12] Source: Gartner, The Data Center Power and Cooing Challenge, David Cappuccio and Lynne Craver, November 2007.

[13] Keeping Your Data Center Cool: There is Another Way: pp. 6 & 8;
http://www-03.ibm.com/systems/pdf/IBM_Rear_Door_Heat_Exchanger-FINAL.pdf

[14] Bernstein Research, Technology Sector Strategy: CFO2 Cautious On End Market Growth In CY08, But Support for CapEx/IT Spending Remains Positive; Will It Materialize?, Richard Keiser and Others, November 26, 2007.

[15] 2008 ASHRAE Environmental Guidelines for Datacom Equipment; July 17, 2008

[16] High Performance Data Centers: A Design Guidelines Source Book; January 2008; PG&E:
http://hightech.lbl.gov/documents/DATA_CENTERS/06_DataCenters-PGE.pdf

[17] http://www-03.ibm.com/systems/x/advantages/energy/design.html Based on IBM power engineering test data. Numbers are average worst case for P6 Burn exerciser program. Like Intel configurations tested in IBM lab. Blade power is average power of total chassis solution.

[18] J. Chase, D. Anderson, P. Thakar, A. Vahdat, and R. Doyle, .Managing energy and server resources in hosting centers,.in Proceedings of the 18th Symposium on Operating Systems Principles (SOSP), Oct. 2001

[19] David Daoud, "IBM Global Financing Brings Structured Asset Disposition to the Mid-Market," IDC Link, October 30, 2006.

[20] IBM Press Release, "IBM Unveils Plan to Combat Data Center Energy Crisis; Allocates $1 Billion to Advance "Green" Technology and Services," New York, New York, May 10, 2007.

[21] Art Wittman, "The Cold Green Facts," Information Week, September 3, 2007,
http://www.informationweek.com/story/showArticle.jhtml?articleID=201803326

[22] Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431; United States Environmental Protection Agency ENERGY STAR ® Program; August 2, 2007
http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency

Greening the data center with IBM Tivoli software: an integrated approach to managing energy.

May 2008

Contents

Data center and facilities managers — along with entire enterprises — have started taking a close look at how they can reduce their energy consumption. And it's easy to see why: the need for computing resources has exploded, stretching the limits of space, power and temperature in the data center. The high capital costs of new or expanded data centers, exponential growth in power costs and the desire to minimize environmental impact are all driving the recognition that managing energy is of critical importance in today's data center. As an analyst from The Robert Frances Group notes, "Power will be the number one issue for most large company IT executives to address in the next 2–4 years. Ignoring this issue will not be an option. Power consideration must be incorporated into data center planning."*

As critical as it is to reduce energy consumption, energy management measures should also be approached intelligently. No organization wants to take drastic measures to reduce energy costs only to pay in the end with poor response times and compromised service level agreements (SLAs). To successfully address the challenges of managing energy, organizations should understand the impact of energy policy changes on the services that the energy supports. And to make intelligent policy decisions, organizations should know the risk that is introduced with each proposed energy-related action in real time.

This paper describes the critical importance of managing energy consumption in data centers and provides an overview of the problems and issues associated with "greening" today's data centers. It then shares insights and solutions that organizations can use to optimize their data center and facility energy requirements while maintaining service levels. Specifically, it describes how IBM Tivoli® solutions offer an integrated approach for managing energy in the context of risk by providing an end-to-end view of IT resources, services, IT and facilities assets, energy costs and response time.

Greening the data center with IBM Tivoli software: an integrated approach to managing energy.

3

Key considerations for the green data center

Energy management has not always been a major consideration in the design and operation of data centers. For many years, most data centers consumed power and space as if prices would always be low, the supply of energy endless and more space always available. Data centers ignored energy factors as serious impediments to the availability and performance of IT services, and the dollar and environmental costs of providing energy were not tremendously high.

Now, however, organizations are taking a closer look at the environmental impact and their current energy usage. At the same time, the demand for energy is becoming so great that it is outpacing supply and driving up costs – not just energy cost factors, but the cost of data center and office space.

Cost-cutting measures such as consolidating on blade servers have enabled organizations to pack more computing power into a smaller footprint. When energy costs were low, this was a reasonable solution. However, the use of high-density servers caused power consumption and heat generation to be concentrated within the data center. This results in a new issue of determining how to optimize these high-density servers to provide the necessary computational resources into the compact footprint of the current data center space. And as servers become ever more powerful – delivering more and more computational strength per square foot – the challenge will become even greater.

Managing energy and risk in the data center

Solving the energy crisis in the data center could theoretically be quite simple: unplug servers, shut down cooling units or even turn off circuit breakers in the data center. Taking this course would dramatically reduce energy use, of course, but unfortunately it would also destroy the ability to deliver the IT services demanded by applications. While data center managers are not likely to go that far, they are likely to pursue policies such as capping server power usage, raising the temperature in the data center, physically moving servers to balance cooling, aligning energy-intensive applications with efficient servers or virtualizing underutilized servers.

Greening the data center with IBM Tivoli software: an integrated approach to managing energy.

4

However, in the absence of a clear view of the resulting impact from energy management decisions, some of these less-drastic actions might still have a major impact on the ability to deliver services. For example, if you cap server power consumption, you need to consider what happens to the response time of applications and SLAs. Are they being put at risk? Are you losing redundancies so that if usage of applications or services spikes suddenly you won't be able to meet demand? And while virtualization provides a great start in optimizing energy costs by helping reduce the total number of servers in the data center, the ability to track usage and monitor service availability can become more complex in the process.

Data center operations must manage energy by discovering how energy is directed throughout the enterprise and optimizing its usage – not just by reducing equipment

Data center operations must manage energy not just by equipment reduction but also by discovering how energy is directed throughout the enterprise and optimizing its usage. This may mean:

- Capping the number of processors in use at any particular time or even shutting down parts of the data center during off-peak periods.
- Obtaining accurate metrics about how much power is being used to provide services.
- Tuning data center operations to match power consumption against performance requirements.
- Connecting changes in IT energy policy with risk to business services.
- Providing management of energy across both IT and facilities resources.
- Monitoring the data center for power consumption, thermal conditions, and energy-related events and situations.
- Shifting workloads within or between data centers in order to save costs or respond to energy events.
- Maintaining IT and facilities assets for energy efficiency.

Continual monitoring and adjustments are needed to help ensure that no more power is used than is required to meet service level requirements at acceptable levels of risk. The right energy management tools can enable you to monitor, control and administer the infrastructure and facilities

in the data center. You can then coordinate the management of energy-consuming resources so specific services can be matched with specific resources as they demand more, less or no energy. With the right solution, this type of coordination of resources might be available autonomously, providing automatic lights-out coordination of resources against service level requirements. With this level of management, only the energy required to maintain desired service levels is used — no more, no less.

Managing energy consumption with Tivoli service management solutions
Organizations have long relied on Tivoli software and its broad range of proven monitoring, event health, performance and automation capabilities. When applied to energy consumption, these capabilities can help data centers adapt application usage to power constraints, and maintain service levels and workload throughput.

Greening the data center with Tivoli software starts with monitoring, controlling and integrating energy with IT assets, the data center infrastructure and facilities assets. The connection to these three key dimensions enables a comprehensive view of energy use in the data center. It also allows energy data to be viewed in the context of service management. This connection to Tivoli service management brings an energy dimension to existing processes and gives organizations increased:

- *Visibility.* Gain an overall view of IT resources, services, IT and facilities assets, energy costs and response time in the context of energy.
- *Control.* Provide recommendations for reducing energy use while maintaining service levels.
- *Automation.* Build agility into operations through the ability to use automated policies for energy efficiency.

The next few sections describe how Tivoli energy efficiency solutions can help you better understand your current energy, application and facility power usage and demand.

To be truly effective at reducing energy costs and carbon emissions, energy initiatives should be established and integrated throughout the organization
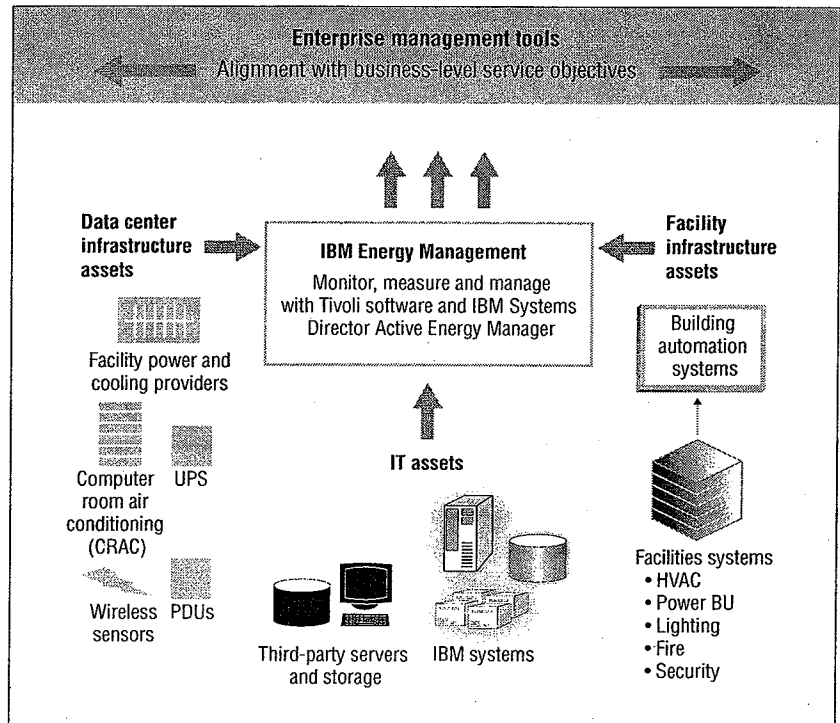
Integrating power and IT

Going green offers the potential to reduce both energy costs and carbon emissions, but to be truly effective, energy initiatives should be established and integrated throughout the organization. In this way, bringing energy and IT together offers the potential for greater oversight and control of data center workload and more efficient use of available energy.

Tivoli monitoring solutions allow you to collect both traditional IT measurements and environmental measurements into a common dashboard that displays an integrated view of power usage, thermal data and application performance metrics. From there, you can feed the temperature data into data warehouses to share with other applications for real-time and historical trending analysis. For example, you might home in on a particular asset that consistently uses more energy than the others. By correlating this information with service level targets, you can take immediate action to slow the system down without impacting SLAs.

You can also set policies to autonomously respond to certain preset thresholds or events to decrease heat generation. As workload increases and decreases, these automated power management policies can continually adjust the power by metering, controlling or capping consumption to save energy while maintaining response times.

In addition, a consolidated view enables you to better assess usage data and financial cost reporting on who is using what resources and to what extent. This allows decisions to be made for chargeback, and provides the basis for decision making about procurement and assignment of additional assets.

Integrating IT and facilities assets
When considering data center energy use, it is natural to first consider the racks of servers or the large storage units. Yet the actual IT equipment uses less than half of the total energy in a typical data center. The majority of the energy used typically is consumed by infrastructure and facilities assets — chillers, UPS systems, air conditioners, power distribution units, humidifiers, lighting and other non-IT equipment.

Greening the data center with IBM Tivoli software: an integrated approach to managing energy.

8

Electricity use by end-use component, 2000 to 2006
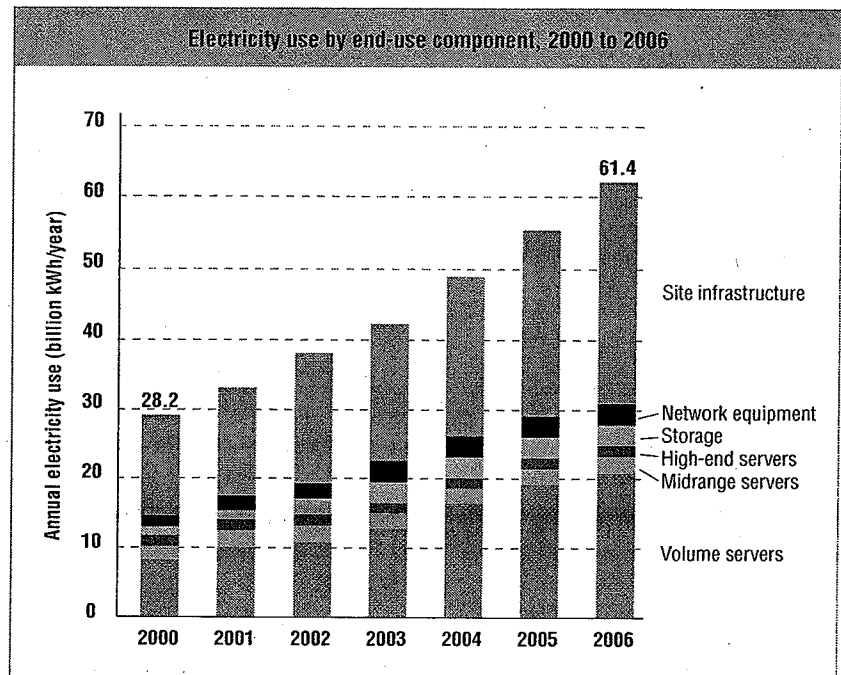
Enabling cost savings and efficiencies requires integrating all of the information of the entire environment.— both IT assets and facilities assets. Not only should data center and facilities managers have access to a common view of energy in the data center, but facilities, IT and finance should use the same data with customized views according to their roles. Visualization promotes quick identification of hot spots and cooling effectiveness — along with the affected assets and by extension, the services most likely to be impacted. Facilities alerts can be integrated with IT events to provide greater awareness of "cause and effects" for IT incidents, such as what failed first — facilities or IT equipment.

By integrating Tivoli solutions with IT assets and facility building systems, assets can be monitored and managed for comprehensive energy, risk and service management

Tivoli solutions can extend the business partner ecosystem to gather data and direct changes within the data center facility, including:

- Moving servers among racks.
- Installing new racks in a different location within the data center.
- Installing supplementary fans and heating and air conditioning equipment to help improve air handling in data centers.

Bringing it all together with Tivoli service management

Collecting and integrating IT and environmental information is a critical element of managing energy. By integrating Tivoli solutions with IT assets and facility building systems, assets can be monitored and managed for comprehensive energy, risk and service management. Service management provides the foundation for integration and policy decisions of energy and risk management, addressing the following questions:

- What SLAs must be met?
- How will the services perform if action is taken to reduce power?
- By saving power how much money are we saving?

Highlights

Based on ITIL, Tivoli service management
solutions work together to help reduce
energy demand

A service management context — or rather, green service management — helps identify the minimum amount of power needed to maintain response times and SLAs. Based on IT Infrastructure Library® (ITIL®), Tivoli service management solutions work together to help reduce energy demand. As an example, after completing a trend analysis on power usage and temperature using Tivoli monitoring solutions, you discover a server that is consistently warmer or uses more energy than the others. You could then utilize IBM Maximo® asset management solutions to identify other servers of the same configuration, and manufacture and initiate a workflow for approval that defines relocation of all such servers for preventive intervention of service performance.

The solutions described on the next page address a range of energy management entry points. Utilizing the established Tivoli infrastructure, proactive energy, capacity, performance and facility management enable the control of IT resources to efficiently match the resources to performance demands by parameters you set and control. This management paradigm extends to coordinate how the facility assets can optimally match application performance and response-time requirements while providing chargeback information for usage of the data center resources.
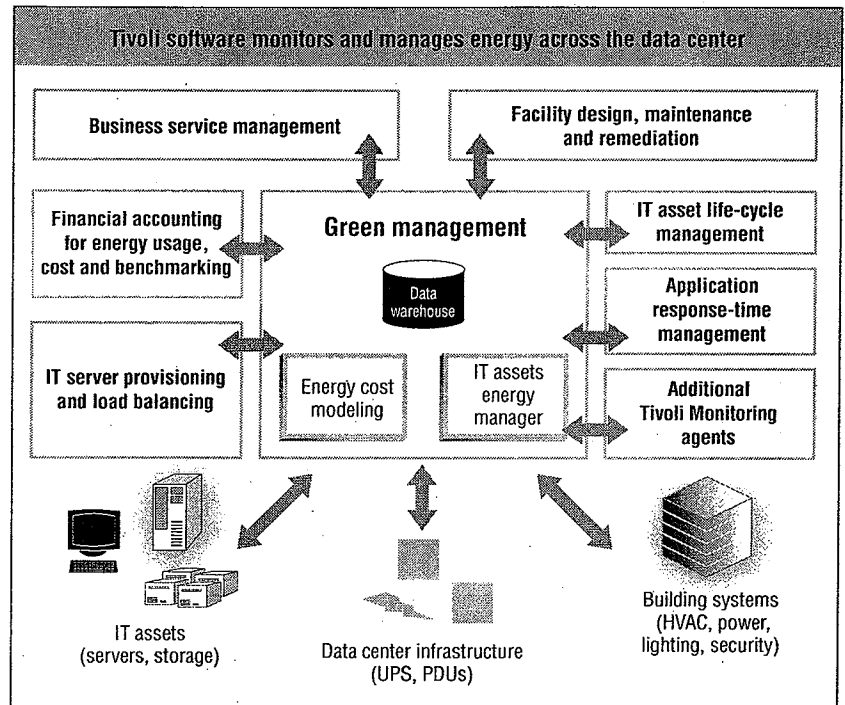
Tivoli software monitors and manages energy across the data center with:

- *Business service management* — illuminates the impact of energy issues on business services.
- *Facility design, maintenance and remediation* — supports processes for facilities management of assets and allows for visualization of data center facilities.
- *Financial accounting for energy usage, cost and benchmarking* — determines and manages power usage and cost to establish benchmarks for savings.
- *IT server provisioning and load balancing* — provides provisioning of systems and redistribution of loads to higher-efficiency areas.
- *Green management* — provides monitoring and management of power usage and thermal data from data center resources.
- *Data warehouse* — stores energy information for use in a variety of energy scenarios.
- *Energy cost modeling* — establishes baselines for energy usage, reports on the amount of power consumed and supports "what-if" analysis.
- *IT assets energy manager* — allows for control over energy characteristics of servers, such as cutting power to processors.
- *IT asset life-cycle management* — enables management of IT asset life cycle to procure efficient assets, maintain them for efficiency and ultimately dispose of them properly.
- *Application response-time management* — provides a view into response time of applications so that the impact of energy measures on application performance can be assessed.
- *Additional IBM Tivoli Monitoring agents* — provide additional information on the IT environment, such as utilization rates, so that they can be a part of energy decisions.

IBM®

Summary

Drawing on a deep understanding of today's energy challenges, IBM provides the breadth and depth of solutions and services that enable organizations to help measurably reduce power consumption and environmental impact without compromising service levels. With its comprehensive range of green service management solutions, IBM delivers the technologies and expertise needed to bring the proper focus and emphasis to energy management.

Although "going green" will remain a race without a finish line, Tivoli software offers solutions and services — and perhaps more important, strategies — to help optimize data center space, power, cooling, facility management and flexibility to exceed customer expectations, reduce costs and support business growth.

For more information

To learn more about how Tivoli solutions can help you manage energy more efficiently — or to find the entry point that is right for your organization — contact your IBM representative or IBM Business Partner, or visit **ibm.com**/itsolutions/servicemanagement

About IBM Service Management

IBM Service Management helps organizations deliver quality service that is effectively managed, continuous and secure for users, customers and partners. Organizations of every size can leverage IBM services, software and hardware to plan, execute and manage initiatives for service and asset management, security and business resilience. Flexible, modular offerings span business management, IT development and IT operations and draw on extensive customer experience, best practices and open standards-based technology. IBM acts as a strategic partner to help customers implement the right solutions to achieve rapid business results and accelerate business growth.

Realizing the value of the green data center by integrating facilities and IT.

May 2008

Realizing the value of the green data center by integrating facilities and IT.

2

Contents

Introduction

Although labor costs still dominate the expenses of operating a modern data center, energy costs, in the form of electrical power, typically are the second-largest expense.[1] The continuing increase in computing demand drives energy costs — both direct power consumption by servers and other IT equipment, and indirect consumption by facilities.

According to the U.S. Environmental Protection Agency, energy consumption by servers and data centers in the United States is expected to nearly double in the next five years to more than 100 billion kWh, costing about $7.4 billion annually. Similar energy cost increases are expected in Europe, Asia and elsewhere. According to one study, worldwide spending on powering data centers is projected to triple by 2010.[2] To compound the problem, server utilization is typically less than 10 percent, driving a waste of $140 billion in "excess" server capacity.[3]

This white paper — along with its companion white paper, "Greening the data center with IBM Tivoli software: an integrated approach to managing energy" — discusses the importance of managing energy consumption in data centers and how systems management technologies contribute to green management.[4] The paper provides an overview of green data centers and the significant role played by direct and indirect power consumption in today's data centers, as well as technology aspects of green data center management. It then describes the specific ways IBM Tivoli® solutions can help optimize energy use in the data center.

Moving toward green data centers

Beyond green initiatives such as reducing carbon footprint and environmentally friendly asset disposal, managing energy consumption is a major factor in achieving a "green" data center. In fact, Gartner Group reports that "green IT" will be the top strategic technology in 2008.[5]

Realizing the value of the green data center by integrating facilities and IT.

3

Highlights

One major obstacle to efficient energy
consumption is the common practice of
separating IT and facilities information

One major obstacle to efficient energy consumption, however, is the common practice of separating IT and facilities information. Traditionally there has been little aggregation of facilities energy information with IT equipment energy information. Yet facilities account for more than half of the energy consumption in a typical data center.[3] With cooling equipment requiring a large amount of electrical power and comprising a large amount of the total energy usage, any improvement in airflow management or power savings from IT equipment (for example, less heat generated) can have additional benefits by reducing the power required for cooling.[4] Components such as humidifiers, UPS units and lighting also offer opportunities for energy management and optimization of the data center.

Breaking down the traditional walls between IT and facilities can provide a critical enabler for managing the green data center. With the ability to aggregate IT and facilities information, organizations can readily provide answers to the questions that enable them to move toward a green data center, including:

- What is the energy impact by business service and resource type?
- How do specific resources affect overall facilities energy consumption?
- How can we maximize utilization while holding power usage constant?
- What is the financial impact of operating the data center more efficiently?
- How might hardware upgrades and consolidations reduce energy consumption?
- How can corporate power policies help minimize energy consumption without disrupting service level objectives (SLOs) and service level agreements (SLAs)?
- How can virtualization improve green efficiency?

Evaluating the technical factors

Physical resources, including servers, storage and network equipment, all consume power and present opportunities for reduced energy consumption. For example, virtualization is a significant technological consideration in today's data centers. Many organizations virtualize hardware and software resources

to help reduce costs and simplify management through consolidation. Using more efficient servers is another straightforward way to help decrease energy costs. To that end, many organizations have turned to blade servers, which deliver dense processing power in a small package.

However, each new energy measure can bring a significant new management challenge as the underlying IT and facilities infrastructure becomes more complex in the process. For instance, although blade centers can decrease energy costs, their higher density also can create power distribution, power availability and thermal management issues. These issues force a new examination of both power and thermal aspects of the data center design.

Realizing the benefits of consolidation and other cost-saving measures requires intelligent systems management technologies that can deliver end-to-end visibility of existing applications, services and facility relationships. For example, the ability to fully optimize virtualization benefits relies on a management system that can manage both physical and virtual systems and can respect existing SLAs.

Given the interdependencies between IT and facilities, the broader facilities of the data center should also integrate into an effective data center energy management program. Accordingly, systems and server management tools should be able to manage servers and facilities aspects such as cooling and power distribution equipment.

With the emergence of "IP enablement everywhere," facilities components are becoming manageable either directly or indirectly. This technology can offer more choices about managing your overall data center and provides the aggregation and integration of data to levels never before possible.

Highlights

Managing energy consumption and associated costs can be relatively straightforward — however, it is a larger challenge when considering that business objectives must be met while controlling power consumption

Optimizing the green data center

Managing energy consumption and associated costs, by itself, can be relatively straightforward — modern IT equipment is more energy-efficient than older equipment, and some power reductions can be achieved with relatively simple steps such as server/equipment powering cycling. However, managing energy consumption and cost is a larger challenge when considering that business objectives (such as SLAs, organizational policies, governance and business processes) must be met while controlling power consumption. This challenge requires deep visibility into the utilization of energy resources across the organization and the ability to control energy consumption in relation to service levels.

Simply becoming aware of usage patterns in the data center is necessary, but not sufficient, to drive effective green management. Automation provides additional advantages to help organizations optimize their equipment and facilities, such as through server cycling or the ability to adjust server levels dynamically to meet user demand. In addition, capital expenditures (server replacement for efficiency) should be considered for total optimization of the data center.

These systems and services management capabilities can be grouped into three broad categories:

- Metric collection, analytics, thresholding and eventing
- Visualization and reporting
- Asset management and spatial awareness

The next few sections explore these capabilities in greater detail.

Metric collection, analytics, thresholding and eventing

Organizations can't manage what they can't measure. It's critical, therefore, to be able to determine the amount of energy being consumed in the data center and surrounding facilities. This requires management tools that can consolidate

energy data by integrating facilities, hardware and traditional IT software management into a single solution. The solution should be able to collect a range of IT and facilities data, create automated thresholding for energy-related actions and integrate with many of the world's leading infrastructure providers.

Managing energy events

A comprehensive event management solution incorporates energy-related events, such as critical component failures. Existing events and metrics, such as CPU utilization, can be exploited for energy management purposes. In addition, other events and metrics, such as momentary and time-averaged power and thermal data, can be monitored and analyzed in an energy management solution.

Understanding business impact

The IT infrastructure's role is to serve business needs. Accordingly, energy management decisions should be made within the context of delivering business services. Systems management should consider the relationships of the data center equipment (servers, storage, networks and so on) and facilities to the business services that operate on that infrastructure. Measures to reduce power costs by throttling server CPUs, for example, should take SLAs into account; business-critical applications must remain available even if servers are in standby mode.

A sophisticated business service management solution can visibly relate applications to the services and integrate facilities data for a clear understanding of potential business impacts.

Analytics and predictions

Transforming facilities data into knowledge is necessary for effective systems and services management. Analytics embedded in management tools can glean such knowledge by correlating events, detecting particular situations in the data

Efficient energy management requires a solution with broad and deep analytics, including event filtering and correlation, threshold violations and policy monitoring for business processes

center environment, determining policy violations, detecting problems and performing causal analysis. Such analytics can also extend to detecting trends and predicting future system behavior as well as devising action plans to achieve the desired behavior.

Efficient energy management requires a solution with broad and deep analytics, including event filtering and correlation, threshold violations and policy monitoring for business processes. Each class of these analytics should encompass not only the traditional IT management perspectives but also energy management aspects of the data center facilities.

Visualization and reporting

Although management tasks are increasingly automated, humans still make determinations such as how and when to act on automated recommendations, what policies are appropriate for their business and which actions to delegate to automated tools.

Customizable management consoles enable "integration on the glass" capabilities that allow multiple management products to effectively manage, decide and create policies that result in effective systems management. In addition, a "launch in context" capability can enable seamless moving from one management domain to another.

A foundation of enhanced visibility drives deeper awareness of the green data center, enabling energy management disciplines and tools to be integrated seamlessly into the broader solution. This awareness, in turn, offers the ability for a deeper understanding of data center power consumption through standard yet customizable reports rich in data and based on a common reporting structure.

Asset management and spatial awareness

Efficient asset management enables organizations to track and maintain the optimal power status operating condition of assets. A sophisticated enterprise asset management solution can track both IT and facilities assets, including generators, pumps and other assets, which, despite considerable energy consumption, are not normally included in the IT infrastructure.

Spatial information — that is, information about the location of assets — is another important factor in data center energy management. Visualizing IT and facilities assets can promote more efficient data center planning and design, as well as help determine optimal device placement.

Optimizing power usage and cost

Once energy consumption information is monitored and consolidated, organizations can leverage this information to visualize and analyze assets to optimize resources and decision making. Greater visibility into energy consumption also enables organizations to better determine current IT and facility energy costs and expenditures.

Information about past and current power consumption and associated costs can lead to recommendations for optimizing energy consumption. Some examples include:

- *Helping reduce power drawn by resources:* When workload demands are low, many IT resources provide the ability to reduce the amount of power consumed. For example, server CPUs can be throttled to decrease power used per unit of time, or servers could be placed in "standby" mode. For example, data center resources, such as a server pool, can be managed to operate within a specified power "cap," or storage networks can be managed to place data on the most energy-efficient storage devices based on the frequency of the data access.

- *Reallocating workload:* Workloads could be moved to different resources, where optimization opportunities exist. Virtualization is one way to accomplish server workload consolidation. Workloads moved from less efficient to more efficient servers — or even to other data centers where energy costs are lower — may decrease energy consumption, associated costs or both.
- *Identifying energy-inefficient assets:* Besides operational costs, capital costs are a significant part of the IT budget. Energy-inefficient assets, whether IT equipment such as servers or facilities equipment, often have more efficient alternatives available. Once energy costs are known, capital costs to replace equipment with more efficient equipment would determine the "payback period" and potential long-term savings from more energy-efficient assets.

These sample techniques used in combination to optimize power consumption and data center costs can be effective ways to decrease energy consumption while retaining alignment with management policies and SLAs.

IBM Tivoli solutions for the green data center

After exploring key capabilities for green data center management, we turn to IBM Tivoli solutions that can help you manage your data center. Tivoli software has a long history of managing IT resources with a wealth of capabilities, including monitoring, managing, thresholding and eventing, combined with extensive visualization and reporting capabilities. Integration with facilities equipment as part of the managed infrastructure enables organizations to leverage these same capabilities to integrate and aggregate facilities data, providing management and correlation among facilities and IT equipment.

IBM Tivoli software is among the first IT management providers to integrate facilities, hardware and traditional IT software management into a single solution

Even though management tools exist for facilities infrastructure from many facilities equipment vendors and some level of aggregated information is available at the facilities level, IBM Tivoli software is among the first IT management providers to integrate facilities, hardware and traditional IT software management into a single solution. The solution provides the ability to collect a range of data, create automated thresholding and actions, and enable seamless integration with many of the world's leading infrastructure providers.

IBM Tivoli software for green data center management

IBM Tivoli Monitoring for Green Energy Management
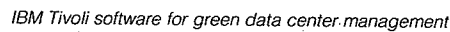
IBM Tivoli Monitoring is a standard-bearer for systems management monitoring. IBM Tivoli Monitoring for Green Energy Management enables a focus on power management and augments traditional performance data with power and thermal information. A corresponding Active Energy Manager data provider for the IBM Director product, also shown in the diagram above, interacts with hardware management modules, monitors power usage and thermal data, and feeds that data to Tivoli Monitoring.

Event integration

As illustrated above, power and thermal event information aggregated with other performance events can be consolidated in IBM Tivoli Data Warehouse. The information can then be visualized through IBM Tivoli Enterprise Portal and managed with IBM Tivoli Event Console.

Facilities and business service management

IBM Tivoli Change and Configuration Management Database (CCMDB) can store information about power and cooling resources and their relationships

to IT equipment. Tivoli CCMDB, along with IBM Tivoli Business Services Manager, enables facilities equipment to be related to business services.

Asset management
IBM Tivoli Maximo® Asset Management helps track and ensure energy-consuming assets are properly maintained for energy-efficient operations.

Spatial visualization
IBM Tivoli Maximo Spatial enables spatial visualization of IT and facilities assets, including GIS-based graphical zooming from site to floor.

Usage and accounting
IBM Tivoli Usage and Accounting Manager can consume the aggregated historical performance and power information stored in Tivoli Data Warehouse and can calculate associated charges for resource usage. In a green data center, Tivoli Usage and Accounting Manager can determine charges for power consumption associated with IT and facilities equipment.

IBM Tivoli Data Center Optimization for Energy Management
This capability of Tivoli Monitoring for Green Energy Management determines financial costs and potential savings associated with power management and saves the data to Tivoli Data Warehouse. This includes data from the IT equipment and facilities equipment. Tivoli Data Center Optimization for Energy Management analyzes the monitored data to produce knowledge and recommendations to help organizations better understand and control their data center operations with respect to energy consumption.

Provisioning in an on demand manner
IBM Tivoli Provisioning Manager offers capabilities to automate workload movement, server power on or off, and tools for automated tasks.

Summary

Energy management is critical for today's data centers. As supply and costs continue to skyrocket, achieving a green data center is expected to become even more imperative. This paper has explored key capabilities to look for when investing in data center power management and discussed the associated business value that can be derived from energy management solutions.

With a broad portfolio of systems and service management offerings that address key capabilities, IBM is at the forefront of data center energy management execution, delivering leading-edge technology with new capabilities that enable green data center management. Through energy management innovation, a vibrant ecosystem of business partners and execution with the Tivoli product portfolio, IBM is making green data center management a reality. IBM continues to build on this momentum by implementing energy management within architectures, products, offerings, services and products.

For more information

To learn more about how Tivoli solutions can help you manage energy more efficiently, contact your IBM representative or IBM Business Partner, or visit **ibm.com**/itsolutions/servicemanagement

About IBM Service Management

IBM Service Management helps organizations deliver quality service that is effectively managed, continuous and secure for users, customers and partners. Organizations of every size can leverage IBM services, software and hardware to plan, execute and manage initiatives for service and asset management, security and business resilience. Flexible, modular offerings span business management, IT development and IT operations and draw on extensive customer experience, best practices and open standards-based technology. IBM acts as a strategic partner to help customers implement the right solutions to achieve rapid business results and accelerate business growth.

[1] Morgan Stanley Research, 2007.

[2] U.S. Environmental Protection Agency, EPA Reports Significant Energy Efficiency Opportunities for U.S. Servers and Data Centers, August 3, 2007, yosemite.epa.gov/opa/ admpress.nsf/0de87f2b4bcbe56e852572a000651fde/4be8 c9799fbceb028525732c0053e1d5!OpenDocument

[3] Jonathan G. Koomey, Lawrence Berkeley National Lab/ Stanford University, "Estimating Total Power Consumption by Servers in the U.S. and the World," February 15, 2007, available from enterprise.amd.com/Downloads/ svrpwrusecompletefinal.pdf

[4] IBM Corporation, "Greening the data center with IBM Tivoli software: an integrated approach to managing energy," May 2008.

[5] Greenercomputing.com, "Green IT will be 2008's Top Strategic Technology: Gartner", October 12, 2007, www. greenercomputing.com/news_third.cfm?NewsID=36071

IBM real-world solutions for economic stimulus

Highlights

- Meet demands for transparency and accountability in stimulus spending

- Protect sensitive information and fight computer hackers and malicious attacks

- Educate with success

- Connect the still unconnected so that more people achieve the benefits of communication

- Discover the power of faster disaster response and greater emergency preparedness

- Address the sharply increased demand for human services

- Implement smarter healthcare systems

Unprecedented opportunity

The American Recovery and Reinvestment Act of 2009 is an unprecedented effort to jumpstart our economy, making funding available to address specific challenges. With our deep experience, skills, technology and solutions, IBM® is uniquely positioned to help you as you consider how best to use your funding or tax incentives. And, if you want to get started on your projects right away, flexible financing options from IBM Global Financing let you match your lease payments to anticipated funding so there's no delay. Here are just a few of the solutions IBM can offer.

Transparency and accountability

The American Recovery and Reinvestment Act sensibly asks that all funds be tracked and the results of the investment measured. To meet these demands for transparency and accountability, you need to connect your spending to results. With the IBM Recovery Act Performance solution, you can:

- Measure and monitor project activities for better decision making and successful outcomes.

- Gather all data and store it in one place for easy queries and reports on funded projects.

- See how, when and where money has been invested and whether it is from stimulus or non-stimulus sources.

IT security

Database attacks. Drive-by downloads. Insider threats. SQL injection attacks. These aren't terms taken from the label of the latest video game. They are real strategies used by hackers to steal or destroy privileged information from agencies and organizations. Fight back with security solutions from IBM:

- *Intrusion prevention technologies* provide protection for sensitive networks and data from both internal and external threats.

- *Protection engines* can help stop malicious Internet attacks before they damage networks or workstations.

- *Threat management* continuously researches vulnerabilities and attacks, making updates so your protection level doesn't waver in the face of new threats.
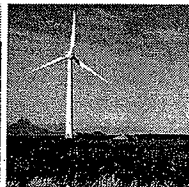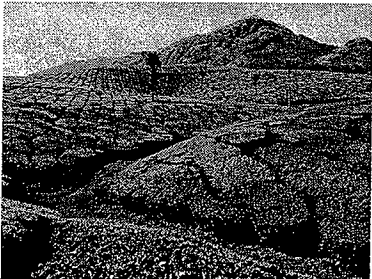
Education

Funds for technology are poised to help U.S. education initiatives. However, simply dropping technology into schools, colleges and universities and expecting their problems to disappear is not the answer. IBM has a proven track record for helping educational institutions achieve their initiatives with these education solutions:

* *Smarter Classroom* improves access to education resources with open technology, and provides tools for personalized learning with data analytics for improved outcomes throughout educational systems.

* *Smart Administration* provides data analysis, integration, and open systems and standards to modernize operations and promote shared services.

* *Innovation in Research* accelerates innovation with world-class, high-performance computing infrastructure and research initiatives.

Telecommunications

Your house called. It says you left the oven on. Can communications really be this smart? Yes, but we have work to do. Broadband Internet access must be available to everyone. There is now funding to develop innovative telecommunications infrastructure that will connect the still unconnected. The following telecommunication solutions from IBM can help:

* *Broadband over power line services* can help rural and public housing residents access the Internet and Web using power lines that are already in place.

* *Broadband Network and Strategy and Integration Services* help companies move to an IP network infrastructure while making the most of the assets they already have.

* *Information Protection Services* and *Unified Support* can ensure that telecommunications data is safe and that networks have continuous technical support.

Public safety and security

The first duty of a state is to protect its citizens. Achieving that is a challenge in an urbanized world that becomes more interconnected, fast-paced and unpredictable every day. Discover the power of increased incident awareness, improved emergency preparedness and better communication among agencies with these public safety solutions from IBM:

* *Real time crime analytics* bring together information stored in different locations to help identify threats and unmask identities.

* *Virtual operations center* helps emergency management agencies follow established incident management processes, coordinate efforts, share information and request resources.

* *Smart Video Surveillance* uses digital video and sensors to alert public safety personnel to developing situations, to support investigations and to aid in the prosecution of crime.

Human services

Sharply increased demand for services. Not enough staff. Heavy caseloads. These are just some of the pressing issues human services agencies face as they sit on the frontline of the economic crisis. The key to improved outcomes in human services delivery is to help agencies work smarter with human services solutions from IBM:

* *Smart Access* reduces the complication of ongoing case management by eliminating unnecessary applications, using community resources and integrating providers.

* *Smart Decisions* uses intelligent processing to help workers make better client decisions, so clients receive precisely the services they need.

* *Smart Process* tracks progress and compares it to performance requirements to increase efficiency and drive out unnecessary costs.

Healthcare

Each year, 1.5 million people in the U.S. are harmed because of errors related to the prescription and administration of medications, 18,000 U.S. lives are lost because of insurance coverage gaps and 24% of Americans report that they do not get medical care because of cost. With economic stimulus funding comes the opportunity to implement smarter healthcare systems from IBM that can help you deal with the problems that cause these startling statistics:

* *Real-time location services* monitor and locate patients and equipment inside or outside healthcare facilities to improve patient safety and help reduce costs.

* *Health information* exchanges support secure information exchange among healthcare stakeholders.

* *Health analytics and performance management* integrate real-time monitoring, data analysis and decision support so care providers can predict and respond to significant events.

Why IBM?

The American Recovery and Reinvestment Act provides more than government funding—it offers a tremendous opportunity to make positive changes in our country and the world. IBM has the experience, skills and resources to be your trusted stimulus adviser. Contact us today so we can help you get started on your projects. For more information, please contact your IBM Representative or IBM Business Partner, or visit: **ibm.com/smarterplanet/stimulus**

IBM.

Rational software

ALM software solutions for green IT.

Syed Raza, Senior Market Manager,

Rational software, IBM Software Group

Contents

Going green beyond the data center

Being a responsible corporate citizen today means more than reducing smokestack emissions and toxic waste. There must be a concerted effort to further reduce damaging carbon emissions throughout the enterprise. As such, visionary organizations are building a business case for using renewable energy sources for designing and producing energy efficient products. "Green" initiatives are being driven not only by the obvious threats to the environment and climate, but also by environmentally conscious customers who prefer to buy green products and do business with green manufacturers.

In pursuing "green IT," technology organizations in particular have already made an excellent start with initiatives to more efficiently manage power and cooling in data centers. Again, visionary organizations in this sector are seeking to take green IT to a higher level as they pursue an environmentally conscious approach to managing software applications and the processes they support.

This white paper will explore best practices for green IT and how application lifecycle management (ALM) can help companies achieve green IT processes for software application management. It will discuss how the IBM® Rational® platform provides integrated ALM and software delivery solutions that support green IT, including:

- *IBM Rational System Architect®, which can help with green organizational transformation.*
- *IBM Rational Rhapsody®, which can assist you with supports green application development.*
- *IBM Rational DOORS®, which can aid in traceability to regulations to prove compliance.*
- *IBM Rational Focal Point™, which can help you align business priorities with product and portfolio management.*
- *IBM Rational Synergy and IBM Rational Change which can help integrate your global systems development and change management.*

This paper will also illustrate the benefits of ALM solutions using examples of IBM customers who have successfully achieved green IT best practices.

Highlights

Why green IT?

According to the U.S. Environmental Protection Agency, carbon dioxide emissions or "greenhouse gases" increased by more than 20 percent from 1990 to 2005[1]. Unless businesses and consumers make conscious choices about energy use, greenhouse gas emissions will continue to rise in the future, with the potential to cause catastrophic climate changes and further damage to the environment[2].

While managing hardware resources is one way to achieve green IT, business software applications also create carbon footprints by utilizing hardware resources that consume energy and create CO_2 emissions. Making software applications greener is an innovative way to achieve green IT goals.

Other factors driving IT organizations to "go green" include:

- *Rising cost of energy, as evidenced by skyrocketing oil costs that peaked in summer 2008.*
- *Increased regulatory scrutiny, with stricter regulations around carbon emissions, water usage, and management of other natural resources.*
- *Customer demand for green products and manufacturing methods.*
- *The need to adopt a "smart products" approach in designing energy-efficient products.*

In addition, global organizations also seek ways to bring geographically distributed employees and development teams together without expending the cost and energy generated by physical travel.

Understanding the regulatory environment

To build a firm foundation for green IT, organizations must have a keen understanding of the global regulatory environment, as well as the financial incentives for green business practices, and long-term sustainability and profitability prospects. For example, an attribute of the Clean Development Mechanism (CDM) initiative—the carbon credits trading market—estimates the value of future contracts to be worth $3.1 trillion by 2020[3]. The greenhouse gas emissions industry is waiting for the passage of cap-and-trade legislation in North America, potentially its biggest market.

The independent, not-for-profit Carbon Disclosure Project (CDP) publishes information on climate change-related issues and other environmental concerns gleaned from responses to their annual information requests. In a press release dated September 22, 2008[4], CDP stated that data collected from 1,550 major global companies indicated that the business world is taking these issues seriously and considers them drivers "of risk and opportunity." The findings also indicated that investors are taking carbon disclosure and climate change reporting more seriously when assessing the "risks, liabilities and opportunities within their portfolios."

Organizations pursuing green IT initiatives can also benefit by creating carbon offsets through projects that reduce greenhouse gas emissions, as pioneered by the Kyoto Protocol[5], which requires 37 industrialized countries and the European Community to reduce greenhouse gas emissions by an average of five percent below 1990 levels between its first commitment period of 2008 and 2012. Yet, organizations can start making a difference immediately with green IT by pursuing carbon abatement policies that start with smarter software and systems that can help to foster green business practices.

How an integrated ALM solution helps promote green IT

Automating and modeling core development and business processes to control energy use throughout the lifecycle is the foundation of green IT—and this requires integrated ALM solutions, which can help organizations promote green IT by improving efficiencies of people, business operations and products in the following ways:

Using embedded software in products to monitor, control, and reduce the energy consumed

IBM Rational Rhapsody software can help developers design embedded systems that are more efficient and less prone to failure, which can help reduce their impact on the environment.

IBM Rational Rhapsody software, a model-driven development environment that addresses the needs of systems engineers, can be used to develop more efficient embedded devices that can monitor and control energy use in electronics. For example, Rational Rhapsody software can help developers design embedded systems that are more efficient and less prone to failure, which can help reduce their impact on the environment.

An IBM Rational customer in the automotive industry is using Rhapsody to accelerate development of a revolutionary hybrid transmission for medium-sized trucks. The new transmission uses hydraulic energy storage rather than electrical battery storage. Developers are using Rational Rhapsody software to model and automatically code the embedded software for the transmission control systems.

The IBM Rational Synergy solution, for software configuration and release management, is also being used by automotive companies and suppliers to build smarter, greener cars by enabling the rapid development of variants and effective delivery of innovative software. Also, its centralized repository model can reduce the number of servers and server workloads for systems development.

Promoting telecommuting and reduce business travel with online collaboration—as well as bring system development teams together for greater efficiency and quality
An IBM Rational customer in the telecommunications industry uses Rational DOORS software for requirements management and the Rational Focal Point software solution for product management and product portfolio management, helping to manage the flow of requirements from multiple project stakeholders to product development teams. Both general and specific requirements,

including green requirements, are placed in Rational Focal Point for analysis. Through an automated process, the development team can give feedback to the environmental team to confirm that the requirements have been accepted, implemented, verified and delivered. As such, the company has full control of green requirements in their product and can easily continually modify them to comply with changing regulations.

Conserving energy and physical resources through more efficient use of underutilized servers
The IBM Rational System Architect solution can aid in linking systems to processes and strategies, so organizations can quickly identify IT infrastructure bloat. System Architect software can aid in highlighting the servers, systems and applications related to organizational business processes, as well as the alignment of these processes to organizational goals and objectives.

The analytics and reporting tools of Rational System Architect software can help business managers analyze the organization's operations, and then establish a blueprint for energy impact analysis.

The analytics and reporting tools of the System Architect application can help business managers analyze the organization's operations, helping them establish a blueprint for energy impact analysis. They can identify redundant and under-utilized systems and servers by analyzing and visualizing power consumption by location, application, processes, strategies and staff. As a result, organizations can consolidate and decommission servers, leading to lower energy utilization of the enterprise—and cost savings. For example, an IBM Rational customer in Europe leveraged the System Architect solution to save $4.2 million in annual maintenance by decommissioning servers.

Highlights

Other IBM Rational customers are using IBM Rational Change software for change management to enable electronic signatures, which reduces reliance on paper documents, a key factor in carbon abatement policies.

Creating a "paperless" organization through use of online forms, images, and communication

Some IBM Rational customers are using Rational Change software for change management to help them develop electronic signatures, which can reduce reliance on paper documents, a key factor in carbon abatement policies. Companies may be closer to the day they will be required to establish emission reduction units (ERU) or their derivatives on their balance sheets as per Financial Accounting Standard (FAS) compliance. Rational Change and DOORS software can provide the traceability needed to establish such an asset on the balance sheet.

Demonstrating compliance with green regulations

Integrated ALM solutions can also help organizations demonstrate compliance with green regulations. Rational DOORS software can help organizations trace green regulations and constraints to their system and software developments to prove that they are compliant. These regulations may differ between geographies, which means that requirements management can be very complex and impossible to track using spreadsheets. The DOORS environment can assist organizations, improve productivity, and aid in reducing the threat of an audit—helping companies save money.

Highlights

Achieving green IT as a responsible corporate citizen will not only serve the goal of creating a greener, smarter planet, but also result in tangible cost benefits and future competitive advantage.

Conclusion

Creating a green IT environment goes far beyond the data center. Automated business and development processes driven by integrated ALM applications can help spread energy efficiency throughout the organization. From electronic signatures that eliminate the need for paper forms, to embedded software that reduces the carbon footprint of today's most popular consumer durables, ALM software solutions can play a significant role in creating a business case for green IT.

The IBM Rational portfolio of ALM solutions can specifically help IT organizations reduce energy consumption and costs associated with multi-site software development by:

- *Reducing energy and resources required to test and run business applications.*
- *Developing analytical models with current and future states of resource consumption leading to greener and more cost-effective strategies.*
- *Analyzing application source code to identify and eliminate unused code to reduce application storage requirements.*
- *Optimizing the performance of applications to reduce server energy costs by reducing server footprint and server processing time.*
- *Managing environmentally focused product requirements throughout the lifecycle.*
- *Supporting the design and build of products and services with low environmental impact.*

Driven by the demand for greener products and production methods, CIOs must find ways to reduce energy use and costs across the IT environment. Most importantly, they must understand the impact of their organization's carbon footprint in order to create initiatives for reducing emissions. Using integrated ALM solutions, today's CIOs will have a head start on making the IT environment in their companies greener, smarter and more competitive.

For more information

To learn more about how IBM Rational and ALM solutions can help you achieve green IT, contact your IBM representative, or IBM Business Partner, or visit:

ibm.com/software/rational

Footnotes

1 Energy Information Administration. (2007). *Emissions of Greenhouse Gases in the United States 2005: Executive Summary - Carbon*. Retrieved June 23, 2009, from http://www.eia.doe.gov/oiaf/1605/ggrpt/summary/carbon.html

2 UNFCCC. (n.d.). *Climate Change Science*. Retrieved June 23, 2009, from http://unfccc.int/essential_background/feeling_the_heat/items/2902.php.

3 Carbon Disclosure Project. (2008). *Carbon Disclosure Project Report 2008 Global 500*. Retrieved June 23, 2009, from http://www.cdproject.net/download.asp?file=67_329_143_CDP Global 500 Report 2008.pdf

4 Carbon Disclosure Project. (2008). *Carbon Disclosure Project Report 2008 Global 500*. Retrieved June 23, 2009, from http://www.cdproject.net/download.asp?file=67_329_143_CDP Global 500 Report 2008.pdf

5 UNFCCC.. (n.d.). *Kyoto Protocol*. Retrieved June 23, 2009, from http://unfccc.int/kyoto_protocol/items/2830.php

Rational software

Using enterprise architecture to develop a blueprint for improving your energy efficiency and reducing your carbon footprint.

Martin Owen, Vice President, Enterprise Architecture Products, IBM, and Robert Shields, Director of Product Marketing, Enterprise Architecture and Business Process Analysis, IBM

Contents

Introduction

Organizations today face rising energy costs and an increased scrutiny of their environmental impact on our world's resources. They are under pressure to find ways to reduce their short-term energy costs and their overall environmental impact in the long term. Regulatory agencies, environmental groups and even investors are closely examining business operations and investments to ensure that organizations are acting responsibly.

Many organizations, especially those in fast-growing industries, recognize the economic imperatives associated with operating more efficiently and reducing their carbon footprint. However, to make smart decisions about being green, an organization needs to develop a shared understanding of its current state of operations and where it wants to be in the future, whether that means in the next month, the next year or in the next five years.

Understanding this evolution opens up a myriad of options for decisions about energy efficiency. Questions that address the long-term consequences of decisions about their energy usage emerge, such as: How does improving the energy efficiency of our data center impact the rest of the organization? What processes need to be changed as a result? What is the long-term impact on our customer service? Are the results consistent with our business goals overall? How do we embrace being green as a long-term initiative versus a short-term fad?

That's where enterprise architecture (EA) comes in.

Enterprise architecture is a formal mechanism for analyzing the energy efficiencies throughout an organization in the context of business strategies, goals and processes. EA offers a central, high-level knowledge source for the analysis of business process, data, applications and systems in the context of organizational goals. EA is both an ongoing process of data gathering and dissemination and a blueprint (or roadmap) that delivers information for analysis, visualization and decision making. A natural result of any comprehensive and ongoing EA initiative can be increased efficiency and productivity, leading to a smaller carbon footprint.

The EA repository serves as a shared information source across the organization for determining an optimized state of operations and providing maximum resource conservation. The result is smarter decision making about energy efficiency, environmental impact and the subsequent effect on the bottom line. EA analytics and reporting tools, such as Telelogic® System Architect® software, help organizations develop a comprehensive EA program that delivers, among other things, a blueprint for energy impact analysis, which is a vital step in undertaking any organizational change.

EA programs can provide a thorough analysis and visualization of power consumption by location, application, processes, strategies and job. For example, IT staff can identify servers and other hardware with the most power consumption and identify targets for replacement or modification. Management can identify "bloat" in the IT infrastructure by highlighting underused or redundant hardware and unwieldy processes. Executives can strategically plan energy reduction initiatives by reviewing reports that highlight trouble areas and their relevance to the organization's key goals, strategies and objectives. An EA program can also provide a communication platform for sharing this information across geographic boundaries and organizational structures. The result is a plan for short-term energy efficiency gains and long-term energy impact planning.

The goal of any program focused on reducing energy costs and increasing efficiency will bear striking similarity to any EA program—more efficient and effective business operations that help achieve the short- and long-term goals of the organization. A natural result of any comprehensive and ongoing EA initiative is increased efficiency and productivity.

The enterprise architect's role in reducing energy costs

EA can be defined as a platform for understanding relationships between high-level business strategies, business architectures, data, processes and their underlying IT architectures. EA plays a fundamental role in indentifying an organization's IT roadmap from an environmental perspective. By linking systems to processes and strategies, EA provides a blueprint for the way a company operates today and its future vision, with the difference between the two providing the roadmap for transformation. Part of this effort is clearly identifying ways for the business to optimize its processes and systems, which would, in this case, equate to a reduction of energy and associated hardware costs.

For example, EA can have a rapid impact by helping IT teams to analyze their application portfolio and identify redundant, underused and obsolete systems and devise a plan for consolidation and retirement. This results in lower energy use for the enterprise. Further analysis can help the team understand system use as it relates to the organization's business processes and, by consequence, how those processes relate to the overall goals and objectives of the organization. With an eye to the future, the team can analyze how to streamline their processes while they study system codependence and future goals and establish a path for migration. The result should be greater efficiency in business operations and a more optimal use of resources.

Importance of enterprise architecture in energy efficiency

EA helps improve the alignment of IT and business by detailing the relationships between the two. In essence, energy efficiency becomes another stakeholder in the EA process—a view to consider along with business process analysts, customers, financial analysts, programmers and others.

A solid EA program offers a common knowledge base for all the affected stakeholders. Extended team capabilities enable access to this information across the enterprise, as well as improved collaboration and communication. EA facilitates the sharing of information with operational staff who recommend the plans; technical staff who implement the plans; and executive staff who review these recommendations, make decisions based on a strategic perspective and authorize the resources to execute the change.

In addition, EA programs can help organizations embrace the factors that make them unique. This includes addressing the distinct challenges presented by energy consumption, such as analyzing energy consumption against environmental policies by country or analyzing energy use by hardware vendor. Enterprise architects must be prepared to customize their plans to address unique challenges. Because of its global focus, EA can help organizations generate a multi-pronged energy strategy that can be executed over time in multiple locations and communicate the impact of changes before they occur.

Using enterprise architecture to analyze and understand energy efficiency

EA integrates an organization's strategy, goals, objectives, staff, business architecture, processes, data, applications, services and systems in a single relational database. From this, information can be analyzed, synthesized and integrated into reports. Analytics features found in the Telelogic System Architect EA solution allow a user to ask questions specific to their needs to understand what IT co-dependencies exist. Visualization features present the information in an easy-to-understand graphical format, tailored to the needs of the audience.

A good EA program can answer questions in three major areas:

1. Energy consumption
- *Which business processes consume the most power and how can those be transformed to greater efficiency?*
- *Which functional organizations use the most power in their daily jobs?*
- *Can you compare the impact of infrastructure power consumption on business processes now and in 2010?*
- *How will our organization's goals, strategies and objectives impact our energy consumption?*
- *Which locations are the most energy efficient, and which are the most inefficient?*

2. IT hardware usage/process efficiency
- *Which servers consume the most power, and how do those relate to the key processes and strategies of the organization?*
- *Which servers are underused and can be eliminated and consolidated?*
- *Which servers have the greatest disposal costs?*
- *What is the carbon footprint of different divisions?*
- *Which hardware vendors are providing the most efficient energy usage?*

- *Which processes consume the most power to execute?*
- *Which processes are affected by a change in our IT infrastructure?*

3. Strategic planning
- *What is the carbon footprint of the entire enterprise?*
- *What happens if we change one of our business goals? How does this change affect energy use within the organization?*
- *Which locations are most affected by power consumption issues?*
- *How do local regulations affect the enterprise as a whole?*

The Telelogic System Architect environment's extensive diagramming, reporting and analysis features can specifically address the issues around energy efficiency and help organizations review their operations from an environmental perspective. Free plug-in software for System Architect is available to help organizations analyze their operations with a focus on energy efficiency.

First, System Architect offers the ability to capture information about hardware power consumption. IT teams can import data from a spreadsheet, presentation or diagramming software (such as Microsoft® Visio®) into the EA. The network concept diagram visualizes how the IT architecture fits together and displays power consumption by each piece of hardware, such as a server. Users can start with basic queries to identify redundancies in the IT infrastructure. Users can see which servers host which applications and the power being used to drive a process.
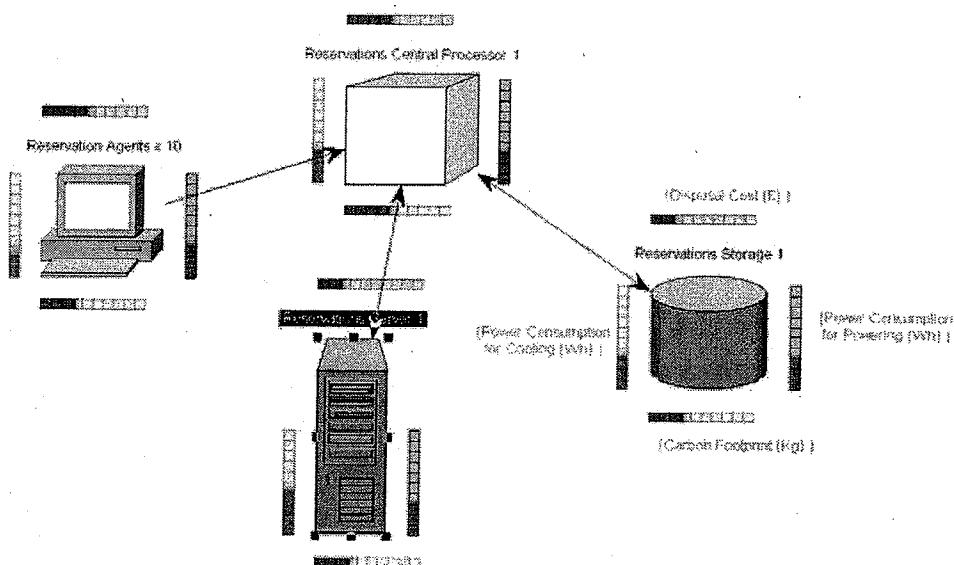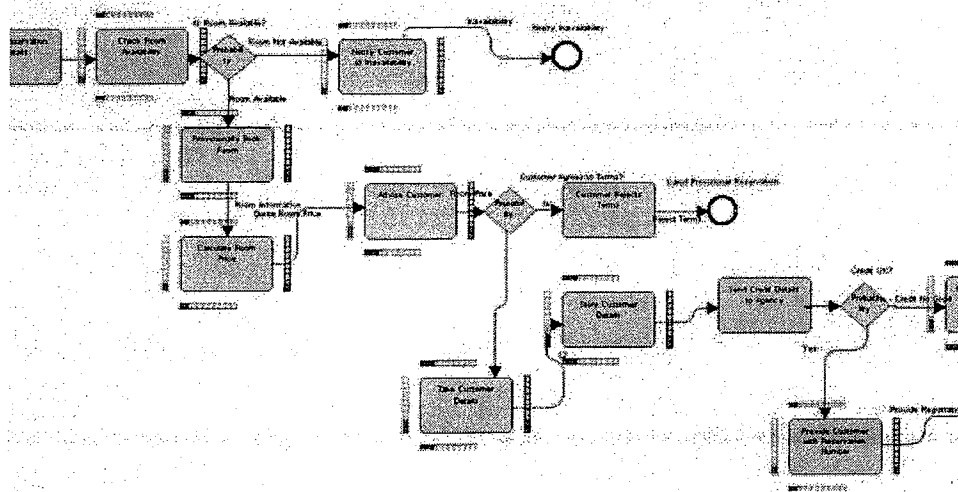

Figure 1: The Telelogic System Architect solution's network concept diagram.

From this, internal teams can also ask questions about their application portfolio and its relationship to its business processes and goals. What is the impact if we retire certain applications? How do we transition to a new system without adversely affecting the users, whether internal or external? From a business processes perspective, what processes can be streamlined, and what is the impact on the underlying application?

Evaluating business value

EA allows organizations to correlate energy consumption to business value. Organizations can use their EA to look at the business value associated with systems, applications and processes. The power of EA lies in its ability to visualize relationships and highlight the impact of a change. By providing this information to its executives, the team can help them make smarter decisions about future investments.

A key to providing this business context is an executive dashboard. This software generates graphical presentations of key technical information. Queries can be made by person, role, application, process, location, etc. For example, a user can ask, "Which applications consume the most power? Which processes consume the most power? Which location uses the most power? Where is the most short-term impact in reducing energy costs?"

Figure 2: Diagram of how Telelogic System Architect software users can generate process analyses diagrams featuring energy efficiency.

Tools such as Telelogic System Architect use heat bars (which look like thermometers) to show levels of power consumption. Users can easily see which systems, processes and locations use the most power. Brightly colored meters show power consumption usage among different locations. Heat maps also provide a high-level view of the organization's key processes, locations and strategies. These can also be color coded to indicate how well they adhere to the organization's business and energy goals.
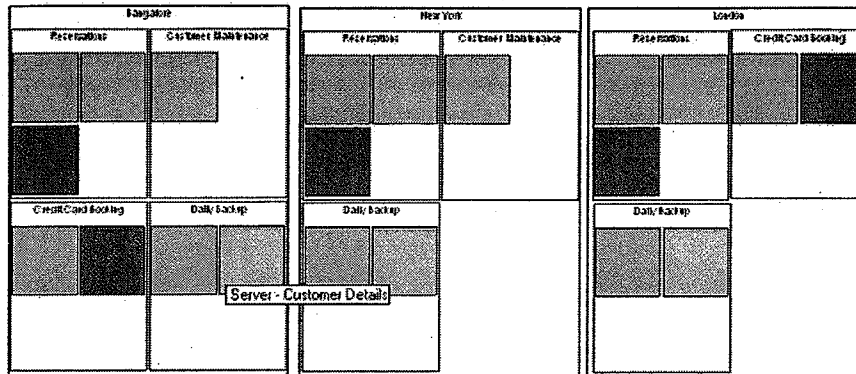
Figure 3: Screenshot of how Telelogic System Architect software can help organizations compare power usage between locations, divisions or departments. This screenshot shows server power consumption among systems in three different locations using colors: green (low), amber (medium) and red (high).

Once an organization understands its current operations, it can use the information to decide a future state of operations and create a roadmap of how to get to that future state. One of the key benefits of EA is helping organizations understand new areas, such as energy efficiency, as both a snapshot in time and as part of a path to the future.

Smaller carbon footprint

EA programs can be especially helpful in a wide variety of scenarios where the end result is the same: staying agile while evolving to greater efficiency and productivity. For example, EA can prove useful to for organizations facing the following challenges:

- *Expansion through acquisitions and the efficient integration of IT operations using environmental impact principles*
- *Modernization of legacy systems by reviewing system use and system redundancies to reduce costs*
- *Sharpening a competitive edge by continually increasing productivity while evolving an IT infrastructure*
- *Development of a carbon footprint baseline by planning a strategy for how to transform business operations over time*
- *Business process improvement initiative by generating a holistic review of all processes for risks, inefficiencies, bottlenecks and quality*

Several organizations have seen the benefits of using EA to optimize their assets, applications and processes. For example, a telecommunications provider experienced a 53 percent savings in IT costs over five years by following a roadmap established with System Architect for consolidating and retiring overlapping and obsolete systems. A major financial institution saved $4.2 million in annual costs by decommissioning servers that were identified using with System Architect.

EA is a highly sophisticated process that provides a detailed strategic view of a company's current and, in many cases, future operations. It helps organizations take into account the myriad of factors that drive the success and agility of an organization.

Using EA as a knowledge source, organizations can establish a blueprint for energy impact analysis and then determine the path to more energy-efficient and cost-effective business operations. They can help analyze legacy applications to reduce costs and enable reuse. They can examine how to improve workloads and operational efficiencies with reliable, scalable and secure business applications.

Understanding of the current state of operations and creation of a future state opens up many options in the decision process. Because EA helps organizations plan for change, it can optimize the benefits and impact of a change, whether in energy usage, organizational structure, application inventory, location change, IT infrastructure or business processes.
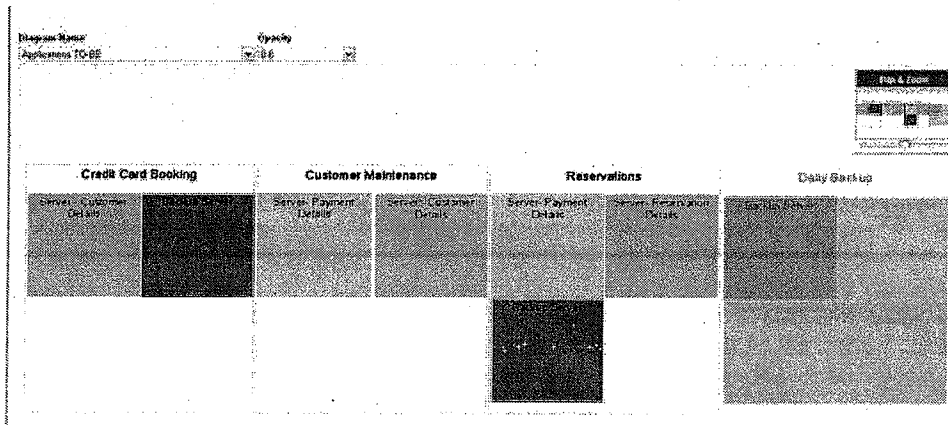
Figure 4: An executive dashboard that shows energy usage now and in the future. System Architect can be used to generate an "as is" analysis of energy consumption of the servers that host applications and then overlay a "to be" configuration to see the impact of the new applications on energy consumption.

Delivery of technical, operational and executive views allow all levels of the organization to make decisions based on information presented in models and visualizations that communicate rich context. Organizations that want to be environmentally aware can use their EA roadmap to implement rapid changes that reduce their carbon footprint and, at the same time, support the organization's goals for the future. Achieving more efficient and effective business operations is the inherent goal of any EA.

For more information
To learn more, please visit:

www.telelogic.com

IBM. ®